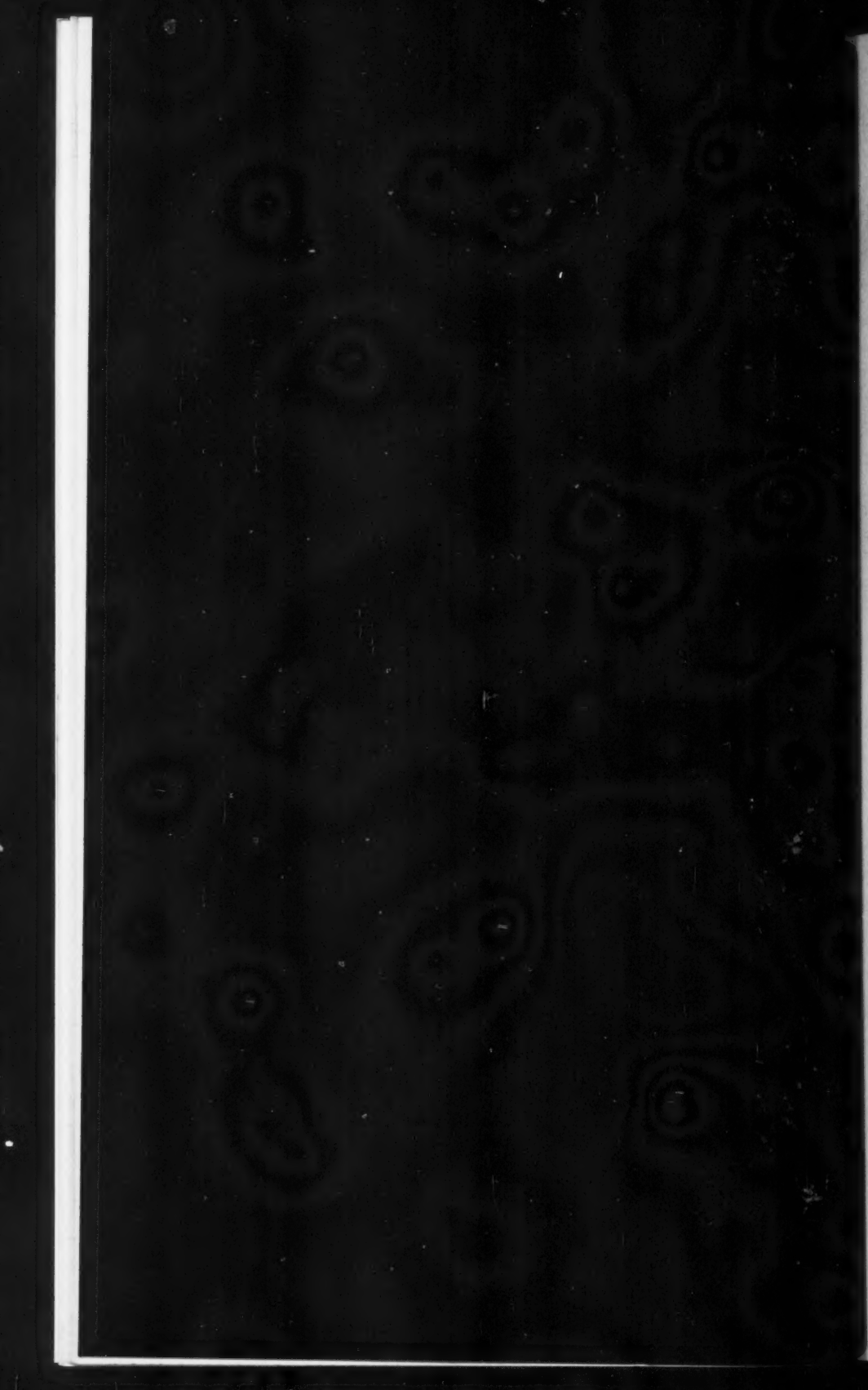

ARMY AVIATION
DIGEST

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CONTENTS

THE COMMANDANT'S COLUMN 3
Brigadier General Carl I. Hutton, *USA*

ARMY AVIATION UNDER WINTER ARCTIC CONDITIONS 5
Major George H. Howell, Jr., *Artillery*

HELICOPTER POWERPLANT SYSTEMS 15
PFC Arthur B. Leak

UER HIGHLIGHTS 23
Major James R. Hodge, *Transportation Corps*

BOOKS FOR THE ARMY AVIATOR 28

THE GRAY HAIR DEPARTMENT 33

STRAIGHT AND LEVEL 40

COVER: L-19 on water skis. Board Nr. 6 CONARC is presently service testing a universal type landing gear for the L-19 at Ft. Rucker, Ala. The gear consists of planing skis designed for landings on dry land, snow, water, swamps, mud, and rough terrain. Its limitations will be availability of beaching facilities for water operations, degree of adhesion in mud, roughness of water, and severity of rough terrain. In water operation the pilot must taxi above the "water stalling speed," (speed at which skis will plane on water), otherwise the aircraft will sink. Water landings are completed by beaching the aircraft, and takeoffs are accomplished by making a ground-run over the beach and into the water.

This copy is not for sale. It is intended for more than one reader.

PLEASE READ IT AND PASS IT ALONG

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THE COMMANDANT'S COLUMN

Brigadier General Carl I. Hutton, *USA*
Commanding General, The Army Aviation Center

The views expressed in this article are the author's and are not necessarily those of the Department of the Army.—The Editor

What is an Accident?

THE TECHNICAL SAFETY definition of an accident is "an unintended interruption of a planned sequence of events." SR 385-10-40 defines an Army aircraft accident as "an ocurrence involving the operation of an Army aircraft which results in injuries to one or more persons or damage to the aircraft or property to the extent of $50 or more."

If the technical definition is combined with that in the regulation and we ignore the damage clause we have:

An Army aircraft accident is an unintended interruption in a planned sequence of events involving the operation of Army aircraft.

Let us take some examples.

Case 1.

An aircraft engine company through a fairly common type of error manufactures seventy-five consecutive engines with a defective connecting rod bolt. These are put into the supply channel and in due course appear on aircraft around the world. In Korea there is an engine failure followed by a successful autorotation. No accident is reported but an Unsatisfactory Equipment Report is submitted on the engine. In Germany the same thing happens. Then at Fort Rucker. Then in Hawaii. Then in Panama.

Up to this time the Safety Director in Washington has not heard of these events nor has the World Wide Accident Review Board. They will hear about the situation as an isolated case only after an aircraft is damaged or personnel are injured in a "pilot error" accident.

Case 2.

A pilot is cleared by ATC to take off, climb on a prescribed heading to a fix, to hold and await further clearance. He proceeds to the fix and is unable to contact the center or any communication station because of the weakness of his radio equipment. At last he proceeds on his original flight plan, a menace in the air. No accident report is submitted, and a violation may or may not be filed.

Case 3.

The concentration of aircraft at a certain Army Air Field is such that only half of the aircraft can be put under cover. A local wind and hail storm damages those aircraft not under cover to the extent of $500,000.00. A Report of Survey writes off the damage, but no accident is reported. The same thing happens repeatedly at the same station over a period of years until the damage mounts to nearly $3,000,000.00.

These show the problem. In every case the system broke down because of the lack of a means to bring command attention to the problem. It would appear that we are more concerned with the disciplinary aspects of aircraft accidents than with getting to the root of dangerous or costly situations. There is supervisory error in each of the cases, but this is ignored because we do not really understand what an accident is. Technically, you have had an accident when you slam on your brakes to avoid a collision, whether any damage was done or not.

ARMY AVIATION UNDER WINTER ARCTIC CONDITIONS

Major George H. Howell, Jr., *Artillery*

The views expressed in this article are the author's and are not necessarily those of the Department of the Army or of The Army Aviation School.—The Editor

FEW PEOPLE in the temperate zone realize the importance of aviation in the Arctic. By 1939 commercial aviation in Alaska alone was hauling 1,000 times as much air freight per capita and carrying 29 times as many passengers as all of the airlines in the United States. Today no other air records in the world can be compared with Alaska's, with the possible exception of those in northern Canada, and most of this flying is done in single-engine airplanes. Air affords the cheapest means of travel in the Arctic region; travel by dog team would cost three times as much as to fly.

From the global geographic and political standpoints, development of Arctic aviation is extremely important. Capitals of all the great powers of the world are closer to the Arctic Circle than to the Equator with about 90 percent of the world's population located north of the Equator and the majority of the world's cities of 100,000 or more population closer to the Arctic Circle than to the Equator. The shortest distance between New York and Tokyo is via the Arctic; and the shortest distance from Chicago to Calcutta, directly over the North Pole. Air travel today and tomorrow will, no doubt, be via the northern route. It is highly feasible that in any future war some or a large part of a potential enemy would choose to fight in the Arctic, and the free world must defend, attack, and counterattack to keep these routes open.

Urgently Needed

In my opinion, Army aviation is needed in the Arctic more than anywhere else in the world. With the aid of Army aircraft, the vast stretches of the Arctic can be reconnoitered with a minimum of time and effort. At times travel by Army aviation might be the only feasible means of transportation. Further, Army aviation is capable of performing all of its normal missions in the Arctic. It is particularly valuable for its missions of liaison, adjustment of artillery fire, communication, evacuation, and emergency supply.

Combat reports from World War II cite many instances in which units were successfully supplied by liaison aircraft. During operations on Leyte in 1944, when three battalions of a division were cut off from normal supply channels, the division air section completely supplied the three battalions for a period of a week, until contact was re-established and normal supply procedures could be used. Such emergency supply would be even more feasible under Arctic conditions.

Army Aircraft Very Adaptable

Army aircraft, with their short takeoff and landing capabilities, can be utilized to a high degree of success for short range supply and evacuation of Arctic regimental combat teams. Such employment is often necessary because of the vastness and remoteness of polar regions in general, the lack of roads and railroads, and the obstacles to cross-country movement created by lakes, rivers, and swamps.

Another advantage of Army aviation in the Arctic is that air

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sections can be located very close to units since landing areas are so readily available. In winter, airstrips for aircraft equipped with skis are limitless because lake, snow, or floe surfaces can be used. In summer pontoon-equipped aircraft and float helicopters can land on lakes and rivers, which are plentiful. Wheeled aircraft can operate on small roads constructed for local ground movement or on small cleared airstrips.

Little Being Done

Although the airplanes themselves and the capabilities of Army aviation are very adaptable to the Arctic, actual aviation operations under Arctic conditions are usually entirely different from those in temperate zones. Yet, to my knowledge, very little has been done to develop this phase of Army aviation. Engineering tests, of course, are being run in Canada, and user's tests are being conducted at the Arctic Test Branch, located at Fort Greely, Alaska. In addition, the Air Force has a comprehensive cold weather hangar at Eglin Field, Fla. Although excellent test activities, these installations can offer little training or experience in actual Army aviation operations under Arctic conditions. For this reason, I feel that action should be taken to establish an arctic indoctrination school for *Army aviators.*

Arctic School for Aviators

At the present time the Army operates an Army Arctic Indoctrination School, to which I was assigned as chief of the Army aviation section in 1950-52. The school, however, conducts only three 4-week winter courses: one noncommissioned officer course and two officer courses. Winter classes can accommodate only 75 to 125 students each. Further, the curriculum is designed primarily for the ground soldier with continuous ski training, 3 weeks of general training in Arctic survival, mountaineering, and tactics, and a 1-week field problem.

If the present school were augmented to include classes specifically for Army aviators, 10 to 20 individuals could attend each class. In their instruction, flying of Army aircraft could be substituted for instruction in skiing. Aviators would receive checkouts in flying ski- and pontoon-equipped aircraft and in making landings on lakes, streams, rivers, and open snowfields. Instruction would

also cover maintenance problems encountered under Arctic conditions, cold weather flying, and actual training with troops in the field. This latter phase could easily be coordinated to use troops or students of the Army Arctic Indoctrination School. The aviation section should be provided with ski- and float-equipped aircraft of all current Army models, including U-1A's, L-20's, L-19's, H-13's, H-21's, and H-34's.

Bush Pilots Pioneers

At the beginning of World War II, little was known about Arctic operations. Much advice was sought from experienced Arctic airmen, including Joe Crossman, the bush pilot who flew the bodies of Will Rogers and Wiley Post from Point Barrow. Later, while chief of Pan-American Airways' Alaskan operations, he wrote an Arctic manual for pilots of that airline. The Army adopted this manual and it became the Arctic "Bible" for airmen in World War II.

There are many other famous bush pilots who have contributed much to Arctic flying, but their contributions are little known in the United States. If the knowledge of the bush pilots of Alaska could be gained and distributed to Army aviators, I feel certain it would be of definite help in the operations of any military unit in the Arctic region.

General Considerations

In the Arctic it is extremely important that the pilot know his aircraft limitations and be fully acquainted with operations peculiar to the particular area to which he is assigned. Much of his flying will be over vast stretches of open water and ice, and with every preflight check he must consider the possibility of landing on uncharted terrain, or unfamiliar icecaps, and of taking off from unusual areas. Because aircraft, or even vehicle mechanics may not be available at outposts where he makes scheduled or emergency landings, the Arctic pilot must have a more thorough knowledge of the mechanics of his aircraft than normally required for the pilot flying in a populated area.

Pilots should have all the instrument and radio training available and must be thoroughly experienced in aircraft navigation. While VFR flying is possible a good bit of the time, weather in Alaska changes suddenly without warning and it is not unusual for

a flight started in clear skies to end in a "white-out." This condition occurs when the pilot can see nothing but white, either because of flying snow or because of an overcast condition which makes the sky white and eliminates shadows on the snow.

Accurate navigation is difficult in the Arctic for two reasons. Compasses are subject to extreme magnetic variations, as much as 70 degrees in areas close to the magnetic pole. Further, visual checkpoints are hard to find, particularly in the winter. Often they are no more than unusual terrain configurations on an otherwise monotonously unmarked white surface.

Aircraft icing is a commonplace hazard. Although icing normally occurs at temperatures from 15° to 32° F., instances have been reported in which ice collected on aircraft in temperatures as low as 10°. At temperatures below 15° moisture in the air is usually in a solid form; however, the heat of the aircraft engine may temporarily melt ice particles, allowing them to refreeze on aircraft surfaces. Unless it is absolutely unavoidable, the Army pilot should not fly through areas of aircraft icing. If icing conditions are encountered, the Arctic pilot knows that frost or ice particles collecting on the windshield are warning signs of ice on wing or rotor surfaces and immediately seeks a suitable landing area.

Learning to choose a suitable landing area on unfamiliar ice or snow-covered terrain, a prime requirement for the Arctic pilot, is largely a matter of experience. Some sign posts, however, will aid the unoriented pilot. For example, ice floes provide excellent landing areas when they are solid enough. Solidity of a particular floe can be judged from the air by the color of the ice. Dark patches indicate near-surface water showing through, making the floe too thin and definitely an unsuitable landing area. This color factor can also be used to judge the safety of frozen lake or river surfaces. The thickness of the ice above the water is another indication of the solidity of a floe to the more experienced Arctic pilot. However, this thickness can vary from 3 to 10 inches, depending on the type of ice composing the floe, and it is usually through experience that a pilot learns to distinguish these ice types from the air.

In a fixed-wing landing on either a floe or frozen lake surface, the pilot should take a quick look at his ski tracks when he first touches down and while he still has forward airspeed. Any discoloration of the tracks again indicates a too thin landing surface, and the pilot must take off immediately. Correspondingly, the helicopter pilot should start shutdown procedures only after he is sure that his

landing surface is solid.

Another hazard to helicopter landings is dry, powdery snow. The wash from the rotor blades picks up the loose snow, and the pilot is likely to be blinded by the flurry, or "white out." For this reason, hovering before a touchdown is generally avoided. Running takeoffs over loose snow are equally dangerous, and more maximum performance takeoffs are used in Arctic operations than in normal temperate zone operations.

Under certain Arctic conditions, a downwind landing is preferable to the usual into-the-wind landing. The prevailing winds over snow-covered terrain cause drifts, much like stationary ocean waves, which have very hard "caps." Handling a ski-equipped airplane or helicopter on such terrain is somewhat like skiing: Into the wind, the aircraft would be landing against natural terrain contours, but downwind, it would take advantage of natural slopes and could slide over the drifts to a smooth landing. Large drifts with steep dropoffs on the upwind side present real hazards to landing aircraft. The snow is very tightly packed and "plowing" into one of the drifts is similar to hitting a brick wall.

Special Techniques

Aside from orienting himself to the handling of airplanes or helicopters equipped with skis or floats and with general weather characteristics of the region, the Arctic pilot must develop certain other specialized flying techniques. For example, if a landing is on a large snow-covered lake, a long landing with enough power to keep the airplane on top of the snow should be used and ended in a 180-degree turn. Taxiing should be continued to about the spot where the plane first touched down, another 180-degree turn made, and the airplane stopped in the original ski tracks. This technique makes fixed-wing takeoffs easier, quicker, and safer and helps prevent overheating of the engine. It is also useful when a helicopter may be overloaded and a running takeoff is required. Unmarked snow creates considerable drag during takeoff, often enough that the additional power required results in overheating of the engine. Sometimes snow is so deep and loosely packed that takeoff without tracks is impossible. Winterization equipment on the aircraft is also a factor in engine overheating in takeoffs through untracked snow.

Areas near streams or feeding tributaries should be avoided because the ice is likely to be thin near moving water. If an airplane

or helicopter is to be on a snow- or ice-covered surface only a few minutes before taking off again a small board or log should be placed under each ski to keep it from freezing down.

In frozen lake landings the shoreline should be kept to the right of the aircraft because taxiing on skis for takeoff is hard to control and torque pulls the aircraft to the left. The upwind side of a lake usually gives the smoothest landing because it is freer of snowdrifts than the downwind side. In the absence of sun and shadow or under "white out" conditions, one way to test the suitability of a frozen lake surface for a fixed-wing landing is to tie a rock to a rope and toss the rock out of the plane. The bouncing of the rock across the lake surface will cause the rope to vibrate. Only slight vibration indicates that the lake is relatively free of drifts and is smooth enough for a safe landing. Marked vibration, on the other hand, indicates a rough surface.

Aerial Supply

Arctic aviators should be well trained in all techniques of aerial supply, which has proved very effective in the Arctic. Army aircraft can drop water, usually in 5-gallon cans; food, usually C-rations or 5-in-1 rations; medical supplies; ammunition; and guns. All standard methods of supply drop are very adaptable to the Arctic. Free-fall drops on snow, with supplies either pushed from the airplane or helicopter or released from bomb shackles, result in less damage to supplies than when this method is used in temperate zones. Blankets used to pad the supplies for the drop serve a double purpose since "extras" are always in demand at the receiving unit. When supplies are lowered on a rope from a hovering helicopter, the rope can be let down directly over a designated point and items arrive completely undamaged. Parachute delivery is probably the most desirable method as far as both pilot and observer are concerned, but supplies cannot be placed as exactly as they can through either of the other two drop methods. Parachutes, however, are easily spotted on the snow-covered terrain, and there are few trees to damage or suspend them.

Survival Techniques

For Arctic operations pilots must have a good knowledge of winter survival techniques. Although only a few cases are on

record where parties were down more than a few hours, it is important that the pilot appreciate this ever-present threat and leave prepared for it on every flight. Unfortunately at the present time no standard Arctic survival equipment adequate for Army aviation needs is available. Although the Army has access to and does use Air Force kits, these are somewhat heavy and bulky for use in Army aircraft. It has been found that the best policy is for each aviator to assemble his own survival equipment, which must vary with specific missions. For example, when deciding what survival equipment to take on a particular flight, the pilot must consider such things as whether he will be flying predominantly over snow or water, how far he is going and how far he will be from civilization if he goes down, the type of aircraft he will fly, how much weight allowance he has above cargo and fuel requirements, and his mission on the return flight. The pilot must also remember that the survival equipment he carries must be sufficient to take care of all crew members and passengers. It is very important that he brief passengers on emergency procedures and survival techniques before each flight.

Barracks bags or old parachute bags make very adequate personal equipment bags. Into one should go such items as an Arctic parka, rubber boots or muklukks, heavy socks or ski socks, an Arctic sleeping bag, and snow shoes. In packing an Arctic survival kit, I use the following checklist for additional small items: compass, matches, axe, emergency fishing and hunting equipment, a pocket knife, cans of bacon, cans of crackers, salt, tea, and bullion cubes. With these items crew and passengers should be able to survive almost indefinitely without undue hardship. The canned bacon is an important detail because the cans can be used as cooking utensils and the fat used to cook fish and game. As holds true for the air soldier as well as the ground soldier under field conditions, a change of socks and underclothing is a must. Additional blankets and a URC radio are also very useful items when weight allowances permit. The Arctic pilot must wear winter flying clothes on all flights, and Mark IV exposure suits are highly desirable on all over-water flights. With these suits, downed persons can survive several hours in the frigid water of the Arctic, whereas they could not with "Mae Wests."

Winterization Procedures

Generally aircraft perform better in the cold weather of the Arctic because the air is heavier. Winterization, such as bafflers on

oil coolers and oil dilution accessories, may be required. If an aircraft is to remain down for some time or parked for the night, the oil and battery must be removed at once. Before an engine is started in the subzero temperatures, the oil should be very hot and the battery warm, and a Herman-Nelson heater should be used to heat the engine. The low temperatures of the Arctic are very conducive to moisture collection in fuel; and for this reason, fuel should be strained through a chamois into an aircraft. Tiedowns are rather simple in the Arctic. Bridges can be cut in an ice surface, oil drums or logs used, or tiedown ropes frozen to ice by pouring a small amount of water over them.

Proper cooling of aircraft engines is particularly necessary under Arctic conditions. First of all, the oil temperature must be allowed to drop low enough for dilution. Two, if the engine is shut down at operating temperatures, the subzero temperature may cause it to cool too quickly, resulting in metal fatigue or vapor locks. Temperature charts are provided with the dilution accessory, but the maximum temperature recommended for dilution is 50° C. Any time oil is not to be drained, for example when an aircraft will be down only an hour, it should be diluted to prevent congealing. Other details which require extra consideration under Arctic conditions include carrying protective covering in the aircraft, double checking of controls during preflight to insure that none has frozen or remains frozen, and strict attention to the draining of fuel sump tanks because of the increased condensation factor caused by the extreme cold.

Engine, wing, and rotor covers should be used on parked aircraft to prevent ice or frost from forming on the surface. Care should be taken to remove even the thinnest coat of frost or ice prior to takeoff. A fibre-bristle brush or broom is recommended, followed by a wiping down of flying surfaces. Solvents or deicing fluids used on rotor blades may cause separation of bonded joints. Heat should not be applied to the rotors unless the helicopter is housed in a sufficiently heated hangar. Otherwise, moisture will fall into the blade pockets and quickly refreeze when heat is removed.

Other than the increased time required for aircraft readying in subzero temperatures, maintenance of aircraft for Arctic operation presents no more problems than are often encountered in temperate zones. One important requirement which adds to maintenance efficiency, however, is a small heated workshop. A portion of the building can also be used for an operations office. All major repairs should be sent to a higher maintenance echelon, where a heated hangar is

available.

Conclusions

In my opinion, the importance of aviation in the Arctic region cannot be overemphasized. The vastness and remoteness of the area makes it one in which Army aviation is essential to effective tactical operations. The stretches of rugged snow-covered terrain and the subzero temperatures present no limitations to the capabilities of Army aviation but require employment and flying techniques markedly different from those used under temperate zone conditions. For these reasons, I believe that an Arctic indoctrination school for Army aviators, established either as a separate school or as an augmentation of the present Army Arctic Indoctrination School at Fort Greely, Alaska, is highly desirable. Training should be coordinated with the existing school, with flying substituted for individual ski training and the final week devoted to actual air support of field problem and operation of an Army aviation section under Arctic conditions. I believe such a school would make important operational and test contributions to Army aviation now that increased emphasis should be put on it in this region.

Following is a summary of some of the specialized considerations of Arctic flying which should be emphasized in such an Army aviation training program.

1. The pilot must know the limitations of his aircraft and be able to perform minor maintenance operations.
2. Unless absolutely unavoidable he should not fly through areas of aircraft icing or in "white out" conditions.
3. Every flight must be planned carefully and navigation checked closely.
4. The pilot must acquaint himself with varying characteristics of the snow-covered terrain and know how to select a suitable landing area.
5. The safety of an unfamiliar snow- or ice-covered landing area should be checked by the color of ski tracks while the fixed-wing pilot still has airspeed and before the helicopter pilot starts shutdown procedures.
6. The pilot must appreciate the hazards of going down in unpopulated, and sometimes uncharted, territory in subzero temperatures and, thus, have a healthy respect for his

(Continued on page 27)

HELICOPTER POWERPLANT SYSTEMS

PFC Arthur B. Leak

The views expressed in this article are the author's and are not necessarily those of the Department of the Army or of The Army Aviation School.—The Editor

SINCE THE END of World War II a tremendous development of the helicopter has taken place. Nowhere in the world has activity in this field been so intensive as in this country. Rotary-wing aircraft have proved their utility and reliability and are now used operationally by the services and by many commercial concerns. Their further development cannot be doubted as new applications are found daily.

While structural design has occupied the engineers powerplant development has gone apace, too. Indeed, these studies and subsequent progressions have paralleled each other. In addition, all of the vast experience and knowledge gained in the fixed-wing field, tempered by the peculiarities of helicopter installation have been applied to the rotor craft.

While the majority of helicopters employ a piston engine and mechanical drive for the rotors, many examples with jet-propelled rotors have been built and flown. With the advent of the large rotor craft, there would seem little reason to not believe that jet-propulsion in one form or another will become more general. No less an authority than Sikorsky has said, "Giant machines, in all probability, will not be designed as enlarged copies of modern small helicopters. In particular, in very large helicopters it would be more practical to apply the power directly to the tips of the blades by use of jets, small auxiliary propellers, or other devices."

For the sake of clarity, let's briefly review the astonishing history of the helicopter. Vertical ascent by means of rotating horizontal propeller has been known from earliest times. The origin of the Chinese helicopter toy, in which a propeller is thrust up a screwed

shaft to make a short ascent and then windmill down to the ground, is lost in antiquity. Leonardo da Vinci, in 1483, made a design he called an "Air Screw" in which sound basic principles were advanced. At that time in history he lacked mechanical power. More than 3½ centuries after da Vinci's death designs were still being produced for manually driven helicopters. By that time, however, the need for mechanical propulsion was realized. Early models were constructed with compressed-air or steam power units.

Reaction-propelled rotor advantages were seen early and there are records of a steam jet-propelled model built by W. H. Phillips in Great Britain in 1842. Jet-propelled rotors in the modern sense may date from a French patent granted to M. A. Quentin in 1909 for a helicopter having four twin-bladed rotors. In this a compressor supplies air to a mixing chamber where fuel is added and the resulting combustible mixture is fed by way of the rotor shafts to combustion chambers in the blades. There have been many interesting variations and scores of designs including ram-jet, pulse jet, and simple jet types. Some were practical and some impractical, over-elaborated and over-simplified. Despite the distraction of their variety, in total they represent an accumulation of investigation that cannot be ignored but are too voluminous for treatment here.

In order to provide organization to this discussion and to assure that all possible systems will be reviewed, the concept of the "Morphological Study" (structure evolution) will be introduced. This method has been used in the missile field with very interesting results.

Morphological Study

In an article of this nature a Morphological Study cannot be presented in its entirety; however, it is an interesting concept and may lend itself to a more complete survey of this field at a later date.

For the review of the field of powerplant system incorporation

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in helicopters, the Morphological Study will be applied in the following manner:

(1) Denote all the various powerplant systems by a letter suffix.

A. Reciprocating Engines.

B. Gas Turbine—Jet, etc.

(2) In the same way differentiate between the various powerplant locations, e. g.:

a. Within fuselage—fixed.

b. Rotor hub—rotating.

c. Rotor tips—rotating, etc.

(3) Mathematically obtain all the various combinations of these systems. For example:

Aa, Ab, Ac.

Ba, Bb, Bc.

(4) Investigate each of the systems that result. For example:

Aa

"Reciprocating engines within fuselage—fixed." This is, of course, the conventional system.

Powerplant Systems

The powerplant systems which will be discussed in this article are as follows:

A. Reciprocating, internal combustion engine.

B. Gas Turbine, Jet.

C. Gas Turbine, mechanical drive.

D. Pulse Jet.

E. Ram Jet.

F. Rocket.

In order to assure that these basic powerplant systems are understood and that their advantages and disadvantages are realized, a brief description of each will be given.

A. Reciprocating, Internal Combustion Engine: In this group, we will consider all those powerplants which produce power in the form of rotating mechanical energy from combustion within a closed volume. This group will include two and four cycle engines, compression ignition (Diesel) or spark ignition. The primary advantages of this system are its economy, dependability and controllability. Its disadvantages lie in its fairly high weight for the power developed and extensive vibrational characteristics.

B. Gas Turbine—Jet: This system effects continuous reaction

propulsion through mechanical compression of inducted air; heating the compressed air in suitable combustors, and acceleration of the heated air by expansion through a jet nozzle; a gas turbine, located in the path of expanding air, serves solely to drive the air compressor. An engine of this nature is a constant thrust producing device, its developed power being dependent on the forward velocity through which the engine is being moved. A secondary effect of this forward movement is to increase thrust slightly due to the ram effect.

The application of this type of powerplant to the helicopter would primarily be on the basis of its ability to produce a large amount of high energy gas.

The advantages and disadvantages of this powerplant system cannot easily be divorced from those of its ultimate applications. In general, however, it may be stated that its overall fuel economy is poor, but improving.

C. Gas Turbine—Mechanical Drive: These powerplants are identical to those discussed in B except that the greatest power produced is abstracted in a rotating mechanical form from the main turbine—compressor shaft. A fairly large amount of usable energy is contained within the exhaust gases which may be used for thrust, etc. Its disadvantages are similar to B.

D. Pulse Jet: Propulsion is effected by the pulse jet by periodic expansion of heated compressed air through a jet nozzle. A series of pressure sensitive valves opened by ram air and closed by combustion pressure, serve to intercept ram air flow during the heating period and provide a reaction wall during the expansion process. This system has never found wide application except for a medium speed unmanned missile. The German V-1 bomb was so powered. Its advantage is extremely simple construction; its disadvantages are poor controllability and the necessity of having a fairly considerable forward speed in order to provide ram pressure. It is, however, more efficient at low air speeds than the ram jet.

E. Ram jet (Athodyds): The ram jet effects reaction propulsion by continuous expansion of heated compressed air through jet nozzles. Compression of the combustible mixture is obtained from ram air entering the unit by virtue of its forward flight. Its primary field of application is in units whose forward speed are within the region of Mach 1 (the speed of sound) or higher. Its advantages are extreme simplicity and low weight; disadvantages are poor economy, especially at low and middle ranges of forward speed, and the necessity of having considerable forward speed in order to

initiate combustion.

F. Rocket: The rocket produces reaction propulsion through high speed rejection of gases produced from reactions of either liquid or solid propellants within its combustion chamber. It has no dependency on an outside oxidizer source (air) and is therefore the only system presently known for space flight. Its ability to provide huge thrust in relation to its weight and size has given rise to its application as an auxiliary source of power for takeoff or emergency.

Its greatest disadvantages are first, large propellant requirements due to the necessity of transporting the oxidizer as well as the fuel, and second, due to the extremely high thrust and temperatures produced, short engine life. This last can be successfully defeated through the expenditure of extensive development time.

Powerplant Location

The location of the powerplant in the helicopter has a great deal to do with the efficiency of operation of the unit. To date the only two locations which have any kind of popularity are:

a. Attached to the fuselage structure and stationary. This is most common.

b. On the rotor blades. Quite a few aircraft have ram jets or rockets fitted to the rotor tips.

Another location which may find utilization and will be considered in this study is:

c. On the rotor hub—rotating.

Without considering the type of powerplant system to be utilized it is impossible to discuss the advantages of the various powerplant locations.

Combination of Systems

As discussed previously, in order to assure all possible combinations, the unification of the various powerplants and powerplant locations will be performed in a purely mathematical manner.

Discussion of Resulting Systems

Other than the more conventional systems, such as the normal reciprocating engine mounted within the fuselage, the following

may have the greatest possible application.

Ab. Reciprocating Engine—on Rotor Hub Rotating: One of the more interesting results of this system description is the adaptation of the old rotary engine and a counter-rotating rotor system. The main rotor would be attached to the crankshaft, the other to the crankcase. Both rotors and engine assembly would be carried on bearings. During operation, the crankshaft rotor would rotate in one direction and the torque reaction would cause the chankcase and its rotor to rotate in the other. It is apparent that no unbalanced torque would be transmitted to the body, thus no torque balancing system would be required. This system is presently being applied in the Nagler helicopter.

Bb, Bc, Gas Turbine—Jet, Rotating on Rotor Blades or Hubs: Due to the very high gravitational forces produced at the tips, the possibility of mounting the engine at the tips is limited. This is not only from the critical blade design but also from the extremely complex loading conditions on the powerplant rotating components. A possible way to reduce these problems is to mount the engines at some mid point on the blades or at the hub itself. The gases produced by the powerplant would then be ducted through the blades to the tip where the gases would be ejected. This type of system has received some attention from the NACA during their helicopter studies and from a number of engineers and inventors. Another possibility would be to have the engines mounted at right angles to the rotor blades at some point intermediate along the blades, thus having the engine operate at a position of lower acceleration loading.

Ram Jet — Pulse Jet — Rocket

As the ram jet, pulse jet, and rocket powerplants are all so similar it is felt that they may be discussed simultaneously. The fundamental difference between the powerplants have been discussed previously. However, as the various applications are reviewed, differences between them will be reiterated.

1. Powerplant Attached to Fuselage: Turbine units can be used to supply air to blade-tip combustion chambers. The largest helicopter built, the Hughes XH-17, first flown in California late in 1952, employs this system of propulsion. The two-bladed rotor is 130 feet in diameter and the overall height exceeds 30 feet. It is an experimental heavy-lift machine and may be regarded as a prototype of future heavy cargo carriers and so-called flying cranes. The

two power units, mounted externally on each side of the fuselage, are modified GE J35 turbojets. Air for propulsion is tapped off the compressors of these units and fed through the rotor hub and blades to multiple jet tip burners, also of GE design. A small, mechanically driven tail rotor is provided to make it more maneuverable. Many other models have been tested and all show great promise, offering the advantages of helicopter performance with substantially improved forward speeds. The advantages of turbine power units are in weight and vibration reduction.

2. Powerplant on Rotor Blades, Rotating: In this category, there have been many successful helicopters constructed. For example the Hiller H-32 uses conventional ram jets at the tips for all its power and the H-19 was given a boost system for takeoff by incorporating small rocket engines in the tips, increasing takeoff power 20 percent. A very rudimentary break down of the various units could be as follows:

(a) Rocket Powered: The simplest and lowest dry weight. The necessity of supplying both oxidizer and fuel, however, increases wet or loaded weight greatly. Its widest application would appear to be, (1) Very simple one man helicopter, "flying bicycle" types; (2) Stand by system, similar to Jato except using a liquid, propellant rocket for takeoff or emergency conditions.

(b) Ram Jet Powerplant at the Tips: This is the second in the order of simplicity for it has no moving parts inherent to its function. Because of the necessity of retaining rotor tip speeds less than Mach 1, the ram pressure is low and overall efficiency is low. A supersonic propeller has been perfected and perhaps a rotor blade can be designed. However, as it is only necessary to transport the fuel, as opposed to the rocket system, a material saving in wet weight is effected. The necessity of providing ram air to establish combustion requires that the rotor be rotated up to some speed, by some outside source, in order to start the unit. The problems which have been found with this system are as follows:

(1) Difficulty of controlling combustion due to the fuel droplets being thrown to the outside of the chamber.

(2) During hovering, power loss due to the engines running in each other's exhaust.

(3) During forward flight the leading engine will have increased ram pressure, and therefore increased thrust, due to the greater relative air velocity; conversely, the retreating engine will produce less.

This particular system would appear to have its widest application to small helicopters with limited range. For large helicopters, the problem of poor fuel economy would appear to negate any reduction in dry weight of the aircraft due to powerplant simplicity.

(c) Pulse Jet Powerplant: The pulse jet is the most complex mechanically of the three types. Its primary advantage lies in its increased fuel economy over the ram jet at the velocities usual at the rotor tips. It suffers from the same problem as the ram jet as well as offering increased dry weight. For application to small helicopters, the choice between the ram and pulse jet would be established primarily by the results of powerplant development for a particular unit.

(d) Powerplant on Rotor Hub, Rotating: At first glance this particular group appear to hold forth no advantages. However, continued analysis brought to light some interesting possibilities. One which appears feasible is to mount concentric with the main rotor mast, a considerably shorter arm rotating at ten (10) or so times the speed of the main rotor through a gear drive. On this arm could be mounted anyone of the type of engines under discussion. The problems with this arrangement are primarily mechanical. A brief discussion of them is necessary in order to fully appreciate this system.

The power produced by thrust units at the end of a rotating arm is given by the thrust multiplied by the velocity at which the engine is rotating.

Power = F (thrust) . V (tip velocity) = FV

The tip velocity is given by the product of angular velocity and blade radius (R) to tip.

(Angular rotational speed is measured in radians/sec. where a radian is a measure of angular arc and equal to 2 π radians/revolution.)

V (tip velocity) = R (blade length) . ω (angular rotational speed)

$V = R\,\omega$

The acceleration, or "g" load, at the tip is given by:

a (acceleration) = R (blade length) . ω^2 (angular rotational speed)

$a = R\,\omega^2$

Or this may be written as:

a = V (tip velocity) . ω (angular rotational speed)

$a = V\,\omega$

(Continued on page 39)

UER HIGHLIGHTS

Major James R. Hodge, *Transportation Corps*

The views expressed in this article are the author's and are not necessarily those of the Department of the Army or of The Army Aviation School.—The Editor

THE UNSATISFACTORY EQUIPMENT report is a vital element of the product improvement program. It is essential that unsatisfactory conditions be reported so that corrective action may be taken, and the UER, submitted to the Transportation Supply and Maintenance Command, is the only authorized method of bringing deficiencies in equipment or procedures to the official attention of personnel responsible for the engineering management of Department of the Army aircraft.

It is realized that there appears to be excessive delay in the processing of some Unsatisfactory Equipment Reports, so that a great deal of time elapses between the submission of a report and the receipt of a reply and/or elimination of an unsatisfactory condition.

Approximately 400 UERs on Department of the Army aircraft and/or tools and support equipment are received each month at TSMC. Each of these must be evaluated and submitted either to appropriate Air Force agencies or to the manufacturer concerned for engineering evaluation and recommendations. Many of these engineering evaluations must necessarily take a great deal of time if they are going to be of any value to the services.

The workload, in TSMC itself, causes a slowdown in the submission of many of the UER acknowledgments. This condition, however, should not discourage using activities from continuing the aggressive submission of reports.

Tech Rep Channels

It is considered timely to mention the apparent increase in the use of manufacturer's technical representatives and their com-

pany channels as a substitute for the Department of the Army UER system. In the case of one aircraft, a company bulletin, recently published, reports approximately 16 deficiencies with recommended fixes, while TSMC has received only three UERs concerning the same aircraft for the same period. This causes a condition wherein Department of the Army actually loses control of maintenance procedures and techniques, and units may engage in unauthorized maintenance practices.

An outstanding example of this situation was the request one activity made to a manufacturer, through tech rep channels, for assistance in a maintenance problem which was about to ground many of their aircraft. The manufacturer had to consult TSMC in order to make financial arrangements and, at that time, it was found that not a single UER had been submitted by the activity which was needing assistance so desperately. Submission of UERs, when deficiencies are first noted, will probably result in the conditions being corrected prior to their assuming critical proportions.

In order to keep all responsible personnel fully informed of UERs submitted and corrective action, TSMC is now compiling a Department of the Army technical bulletin titled "UER Digest," which will be published on a monthly basis. This technical bulletin will replace the need for individual replies and should stimulate the entire program.

Following UERs are typical of those received at TSMC in the past 30 days. It will be noted that several are classified as "isolated cases." These are being published with the hope that if they are not actually isolated cases, seeing them referred to as such will stimulate the submission of additional UERs.

H-34

Problem: Two UERs received reporting loss of H-34 cabin doors in flight.

Results of an investigation revealed the tip of the S1620-61203-5 handle assembly is too long and rubs on the S1620-61210-2

The UER Highlights Department, *prepared by Major James R. Hodge, is compiled from information contained in Unsatisfactory Equipment Reports received by the Transportation Corps Supply and Maintenance Command, 12th and Spruce Streets, St. Louis 2, Mo. Major Hodge is Chief of TSMC's Aircraft Maintenance Engineering Division.—The Editor*

track housing, causing the S1620-61203-25 rod assembly to be pulled out of the locked position whenever the cabin door is opened.

To prevent the possibility of loss of the cabin door during flight or inadvertent jettison while on the ground, the activity submitting the UER recommended the S1620-61203-5 handle assembly be trimmed off approximately 1/4 of an inch at end protruding through rod assembly, and this suggestion will be reflected in detail in a forthcoming TB AVN. The contractor is in the process of proposing a more extensive modification to the cabin door to provide increased rigidity to maintain correct alignment of the door. This engineering change should provide a firm fix regarding the problem.

H-34

Problem: One UER received reporting a fuel leak in the S1630-62412 forward right hand fuel cell at the seam between the drain and the center fuel cell attachment flange on an H-34 helicopter.

Since no additional reports have been received reporting like discrepancies, this project is considered an isolated case and closed accordingly.

H-19

Problem: One UER submitted indicating that difficulty had been experienced in lubricating (hand pack method) the tail rotor counterweight hinge assembly on an H-19. It recommended that in order to assure a positive and simplified method of lubricating, the 105 inch tail rotor counterweight bearings, nut, Part Number S14-15-4426, be modified to incorporate a "Zerk" Grease Fitting.

Although this is the first report received pertinent to the lubrication of the counterweight hinges assembly, action was taken to incorporate submitting activity's recommendation, resulting in a Technical Bulletin containing instructions for necessary rework of nut, Part Number S14-15-4426, parts and material required. Reference TB AVN 21-12, subject: Modification of S14-15-4426 Nut, H-19 Helicopter.

H-19

Problem: One UER submitted by 40th Transportation Battalion, APO 613, citing throttle linkage bolt chafing on sound proofing at Station 95.5, on H-19s.

All Army commands operating H-19 helicopters were advised of the above discrepancy and were requested to conduct an immediate inspection for possible chafing of strut assembly, Part Number S1430-3087 (H-19C), Part Number S1430-3147 (H-19D), on sound proofing at bellcrank assembly, Part Number S1430-3085. It was also requested that activities submit UERs and photographs on each discrepancy noted. However, since no additional UERs have been received, an investigation is not warranted at this time. This report is considered an isolated case and classified non-project.

H-25A

Problem: Emergency UER was received reporting loss of lateral control of H-25A helicopter immediately after takeoff. The helicopter crashed and suffered extensive damage. Investigation revealed the aft lateral screw-jack had become disassembled from the upper bearing housing due to the screw-jack lock washer safety wire breaking.

To prevent the possibility of recurrence, two Technical Orders were published. T.O. 1H-25A-527, 13 January 1956, outlined the inspection to be performed on all screw-jack assemblies for indications of internal looseness. T.O. 1H-25A-528 requires removal of all unmodified screw-jack assemblies and replacement with modified assemblies which incorporate redesigned locking features to prevent accidental disassembly.

H-25

Problem: UER was received reporting that new rotor hub rain shield collar assemblies, Part Number 18R6045-1, on an H-25 were received with the inside diameter of the collar machined .008 inch undersize. It was further noted that this discrepancy existed on four new rotor hubs which had been received.

Investigation of this discrepancy indicated it to be a quality control responsibility of the contractor. The fit of the collar assembly is not considered critical as the tolerances of the collar inside diameter are plus or minus .02 inch. This report was the first received on a discrepancy of this nature and is considered an isolated condition.

H-21C

Problem: UERs received indicated malfunction of clutch engagement to jaw position of H-21C helicopters. Submission of the UERs resulted in an investigation of the clutch sub-assembly. This investigation revealed that the roll pin was missing, allowing the lock nut to loosen and hold the clutch jaw from engaging. This condition was attributed to lack of sufficient expansion forces in the split end of the roll pin and/or oversize hole drilled in the bearing lock nut, allowing the pin to fall out.

As a result of the investigation, the manufacturer initiated the following corrective action:

a. Deletion of the roll pin and incorporation of a lock washer and a lock nut in its place.

b. Redesign of the drum and retainers to accommodate the outer lock washer.

An Engineering Change Proposal has been initiated recommending retrofit of the above modification at time of overhaul.

H-21

Problem: One UER received reported insufficient grease in the rotor control universal block bearings on the H-21 helicopter. The UER indicated the required daily greasing had been accomplished. Apparently the grease was not reaching the bearings.

No additional reports citing like discrepancies were received. The project was considered an isolated case and closed accordingly.

(ARMY AVIATION UNDER WINTER ARCTIC CONDITIONS

continued from page 14)

survival equipment and survival techniques.

7. Preheating procedures and oil dilution are essential to the operation of aircraft under Arctic conditions.

8. Because of the danger of loose snow, helicopter pilots should be particularly proficient in maximum performance takeoffs and in landings from which hovering has been eliminated.

BOOKS

For The Army Aviator

PANZER BATTLES—*von Mellenthin, F. W. (University of Oklahoma Press, Norman, Okla., 1956. $5.00)*

Reviewed by Lt. Col. Thomas W. Anderson, *Inf*

From the classic victories executed by the German Army in Poland, France, and the Balkans during 1939-1941, to the tragic defeats in Russia during 1944, this book gives the reader a profound insight into the cool professionalism and capability of the German soldier. A book of such wide scope, ranging through the early German successes of World War II, the battles of the Western desert, Russia, and the final struggles in the west, can necessarily only touch on the highlights of each campaign. However, General von Mellenthin manages to imbue with drama and suspense each action he writes about and impartially criticizes or compliments the individuals playing the major roles.

Von Mellenthin's style is pleasant and never heavy handed or unduly wound up in German military terms which would be beyond the lay reader. This is a review and discussion primarily concerned with tactics and deals with strategy and logistics only to the extent necessary to insure completion of the tactical picture.

There are several facets of this book which should appeal to the military reader; the reasons for the early successes of German armored employment despite inferiority to the allies in numbers and equipment; the evaluation made of the nature of the Russian soldier, his methods, his capacities, and his weaknesses; the techniques employed by German tacticians and combat commanders such as Rommel, Balck and Manstein as viewed during the author's close association with these military leaders.

The author has no particular axe to grind, either political or military, and this book presents as objective a review, and discussion on the great campaigns of World Kar II, as is possible from one who was an active combatant in every theatre of the European War from 1939 to 1945.

Panzer Battles will take its place as a reference for students of military history and tactics, as well as provide worthwhile reading for those interested in exciting, informative works of this nature. Particularly provocative thinking will be generated by those readers interested in discovering new application for unchanging principles of war.

Lieutenant Colonel Thomas W. Anderson *graduated from Pennsylvania Military College in 1942. He is also a graduate of the Infantry School Associate Officers Course (1952) and the Command and General Staff College (1954).*

He served with the 26th Infantry Regiment, 1st Div., in WWII, and fought in North Africa, Sicily, and participated in the Normandy invasion. He saw action in France, Germany and Czechoslovakia.

After instructing in the Virginia National Guard, Col. Anderson received flight training at Connally AFB, Texas, and at Ft. Sill, Okla. He is qualified in both fixed- and rotary-wing aircraft.

He served as Division Air Officer with the 3rd Inf. Div. during the Korean War, and is presently assigned as director of the Department of Tactics, The Army Aviation School, Ft. Rucker, Ala.—The Editor

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AIR NAVIGATION *(Fourth Edition)—Weems, P.V.H. (Weems System of Navigation, Annapolis, Md., 1955. $6.00)*

Reviewed by Lt. Col. Carl I. Sodergren, Arty

Many of the present methods and techniques of air navigation used by the Army aviator today are contained within this fourth edition of Air Navigation. Its treatment is complete and authoritative, sufficient to meet the needs of any pilot; yet, so simple and direct that the beginner pilot will have little trouble in understanding and applying the methods described. In addition to the more familiar methods of navigation such as pilotage and dead reckoning, the book surveys electronic navigation, pressure pattern flying and celestial navigation.

The Army aviator's "Piper Cub" days are history and it is becoming more evident, each day, that aircraft capable of flying great distances are needed to carry out the role assigned Army aviation in support of the field forces. This evolution dictates the need for Army aviators to become familiarized with these new methods

of navigation to the degree that they are prepared to employ them when required. Primarily, pressure pattern flying and celestial navigation are associated with over-water flying but this capability of our Army aircraft is not preposterous considering the great strides that have been made in small aircraft as well as helicopters.

The requirement for the Army aviator to learn electronic navigation exists today and this subject must be thoroughly understood to make possible the capability of instrument flying. The primary electronic navigational subjects covered by this book are Low Frequency, Omni, Loran, and Consol. Today most of us are familiar or have a working knowledge of Low Frequency and Omni, but Loran and Consol are systems that are relatively new to the Army aviator. Basically, Loran provides the navigator with a line of position by means of the measurements of the time difference in the reception of radio signals from two ground stations. As in radio and celestial navigation, two such lines of position constitute a fix. Loran has two great advantages over any other method of long range position fixing in that it is an all weather facility, for the most part unaffected by rain, thunderstorms, clouds, icing, or other meteorological disturbances. It also provides the means for obtaining an accurate fix in a minimum amount of time. Consol is a reasonably accurate long range navigation aid serving an area, generally the Atlantic Ocean and Europe. The primary advantages of Consol lie in the fact that its signals can be received by any ordinary low frequency radio receiver and no other special equipment is necessary.

Every Army aviator will find that the possession of this book will be a valuable asset to him for use as a ready reference and provide a better understanding whereby he can broaden his scope of navigational knowledge.

Lieutenant Colonel Carl I. Sodergren *is director of the Department of Fixed Wing Training at The Army Aviation School, Ft. Rucker, Ala. His aviation experience goes back to 1943 when he graduated in class number 29 at Ft. Sill, Okla. During WWII, he was Air Officer of the 76th Inf. Div. in Europe and upon his return to the ZI was First Army Assistant Air Officer. Colonel Sodergren was X Corps' Artillery Aviation Officer during the Korean War and later served as the First Cavalry Division's Aviation Officer until his assignment with The Army Aviation School in 1953. He is qualified in all types of Army fixed- and rotary-wing aircraft in addition to being qualified as an instrument examiner.—The Editor*

The following book reviews were compiled by the ARMY AVIATION DIGEST *staff. Views expressed are not necessarily those of the Department of the Army or of The Army Aviation School.—The Editor*

CAVALRY OF THE SKY—*Montross, Lynn (Harper & Brothers, 49 East 33rd St., New York 16, N. Y., 1954.)*

Although this book is not a new one, it is one which Army aviators will find especially interesting since the development of the use of rotary-wing aircraft in the Marine Corps so closely parallels the development in the Army.

When the atomic explosions rendered obsolescent the system of amphibious warfare that had won decisive victories in World War II, the Marine Corps set itself the task of reshaping its concepts. Tactical dispersions, they decided, gave the answer—a dispersion of ships and men which could only be made possible by a new vertical approach. And only the helicopter appeared to fill the need.

Upon the outbreak of the Korean War, the Corps was ready with an air observation squadron which carried out helicopter command and staff flights, reconnaissance, wire-laying, evacuations of casualties and rescue work. When the 1st Marine Division was assailed by eight Chinese Communist divisions in the early winter of 1950, helicopters often provided the only contact between units separated by enemy action. Next, Marine helicopters were making front-page headlines by such combat operations as the lift of an infantry battalion.

In the meantime, while these Marines were creating tactical history in Korea, other Marine helicopter squadrons were training in the United States. More than 2,000 Marines participated with 39 helicopters in the Desert Rock atomic bomb exercises held in Nevada in the spring of 1953.

The conflict in Korea did for the helicopter what World War I did for the conventional airplane. *Cavalry of the Sky* tells the story of these developments in the Marine Corps from official records. It is a story of ingenuity and drama, and one in which the Marine Corps takes pride. The book is illustrated with 32 pages of halftones and 12 pages of line drawings and maps, plus a glossary, index, and bibliography.

GUIDED MISSILES IN WAR AND PEACE — *Parson, Jr., Major Nels A. (Harvard University Press, Cambridge, Mass., 1956.)*

In the foreword to *Guided Missiles*, Gen. John E. Dahlquist, former commanding general, Continental Army Command, said, "This book has been written by one of the officers in Combat Development to preclude the necessity of reading many volumes on the subject. Major Parson has presented in one concise package the important information that can be released. He has organized the book so that the reader may find at once that facet of the field in which he is particularly interested."

Guided Missiles is an outgrowth of two graduate-student papers written at the University of Southern California. The first, a research paper entitled *An Introduction to Guided Missile Training, USC*, was prepared to give Army graduate students background knowledge in guided missiles before they undertook the more advanced course. The second is a thesis for the Master's Degree entitled *The Impact of Guided Missiles on Military Strategy*. Much more need not be said; the book is well written and organized. It is a starting point for those interested in guided missiles; particularly persons whose knowledge has been gained from the Sunday supplements and news stories.

FOR PEOPLE UNDER PRESSURE — *Fink, Dr. David H. (Simon-Schuster, Inc., New York, N. Y., 1956.)*

Dr. Fink, a Hollywood psychiatrist, has attempted to write a book for people who live under pressure. If you happen to be one of them (and who isn't?) you'll like this book for its simplicity in answering what probably is the most representative questions that patients bring to his office.

Today, nearly everyone is under pressure to fit together in a single, satisfying picture the conflicting demands of spouse, job, children and budget, not to mention the importunate demands made by relatives, friends, neighbors and whatever organizations one may belong to. At the same time, one must work out a life that is purposive, satisfactory and meaningful. It's a universal problem and while this book is no cure-all, it does tell one how to think things through for themselves, which in final analysis is a great deal.

The Gray Hair Department

IT IS AN ELEMENTARY FACT that at the present time aircraft engines will not run without gasoline. Aviators certainly know this, but from time to time some allow themselves to get caught in what is really about the most embarrassing situation which it is possible for a pilot to find himself in. Only in very rare exceptions can any fault be traced to anyone except the pilot. In many cases, there are other

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Capt. John L. Rodrique, *the very senior Army Aviator above, is an instrument flight instructor at the Army Aviation School, Ft. Rucker, Ala. His military flying career began with glider pilot training in Iowa in 1942, after which he attended Army Pilot Training Class Nr 10 at Fort Sill. He graduated as a flying sergeant.*

During WWII he became Battalion Aviation Officer in the 3d Inf. Div. in Europe. Following the war, he transferred to the 88th Inf. Div. for occupation duty in Italy. Since then, he has served as Aviation Officer with the U. S. Constabulary in Germany, the 4th Army Headquarters in Texas, and the 2d Armored Division in Germany. He received his assignment to the Army Aviation School in 1954.

While on occupation duty in Germany he received the first L-19 to be shipped to Europe and flew it on a special mission to North Africa. While on this mission he established another first for Army pilots by flying the Mediterranean Sea in an L-19 from Tunis to Palermo, Sicily.

Capt. Rodrique has logged over 5,200 hours pilot and instructor pilot flying time in all types of Army fixed-wing aircraft.—The Editor

factors at work. Passengers, especially senior ones, are in a hurry to complete a flight. Nightfall causes a pilot to take a chance.

Too Little Too Late
H-13E

Upon completing a long mission, an H-13E pilot was requested to make a reconnaissance flight for a unit commander. Making arrangements for fuel to be delivered to a proposed landing site, the pilot took off with his passenger.

At their stopping place, the pilot checked the fuel supply and the "dip stick" indicated six gallons. However, the helicopter was parked on a slope with the gas tank filler cap on the low side. The pilot took this into consideration and estimated that he actually had four to five gallons remaining. The passenger, a colonel, was anxious

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The Gray Hair Department *is prepared by the* ARMY AVIATION DIGEST *staff with information obtained from the files of the Army Aviation Safety Board. The views expressed in this department are not necessarily those of the Department of the Army or of The Army Aviation School.—The Editor*

to continue or return to the CP and asked the pilot if the helicopter had enough fuel to return. The pilot replied that he was sure there was enough fuel in the tank for a return trip to the colonel's CP. Instead of waiting for gas to arrive from the airstrip they took off.

The pilot estimated that the trip back would take approximately seven minutes. He had accumulated one hour and thirty minutes flying time approximately.

Several minutes after takeoff, over a heavily wooded area, the engine sputtered and quit and the pilot immediately bottomed the collective pitch, placing the helicopter in autorotation. He made a full flare over the tree tops and lowered the helicopter into the trees as gently as he could.

Primary Unsafe Act: " . . . the pilot took off with insufficient fuel to complete the proposed flight. This act was committed even though he checked the fuel level prior to takeoff."

Contributing Factor: "Flying with insufficient altitude over a wooded area, to complete an autorotation into a cleared area, in the event that an engine failure might occur."

The Army Aviation Safety Board concurred and commented that, "Evidence contained in the report of accident establishes that this accident was the direct result of poor judgment on the part of the pilot in attempting flight with a known condition of low fuel and over wooded terrain where a safe emergency landing could not logically be expected to be possible."

Planning Based on No Wind Change
H-13E

An H-13 pilot was dispatched to the Division command post to fly the Commanding General on a reconnaissance mission.

Proceeding on a pre-determined course, they flew into strong headwinds. The pilot reasoned that he could extend his flight out further than the normal time for return because on the return flight, flying with the wind would make up for the time lost going against it.

On the return flight, the pilot suddenly realized that it was taking longer than expected. Checking closer, he realized that the wind had changed and instead of having a tail wind, he was encountering another headwind. Knowing that fuel was critical, he landed at a MASH unit, but found they had no gasoline; however, he was informed that a QM depot, located approximately 12 miles away had aviation gas. The MASH stop took about three minutes, and

during this time on the ground, the pilot measured the tank with a stick and speculated that he had enough fuel for the 12 mile trip.

He flew for ten minutes toward the depot; then, suddenly, the engine sputtered and quit. He was flying at 700 feet altitude, 60 miles per hour, and over a road bounded by a large wooded area on both sides. The pilot put the helicopter into an autorotation and lined up with the road. The road was hard surfaced, with a layer of loose gravel on top. The pilot's intended point of touchdown was near a shallow curve in the road. As he cleared the trees, he flared the helicopter, and just before landing swung the tail to the right. His landing would also be on a down grade. He turned to the right to stop forward movement and the possibility of sliding off the curve and into the trees. The helicopter touched down on the road-side, practically over a ditch; and the tail rotor dug into the ground on the other side of the ditch; and the right skid was bent.

Primary Unsafe Act: "Violation of AR 95-8, para 19, dtd 3 Dec 1954, (30 minute VFR fuel reserve not taken into consideration by the pilot)."

No contributing factors were listed.

The Army Aviation Safety Board concurred in the findings of the Aircraft Accident Investigation Board.

Poor Fuel Management
L-19

An L-19 pilot was flying his passenger on a cross-country reconnaissance. The flight, which included three stopovers, lasted 2 hours and 25 minutes when suddenly the engine began sputtering. The pilot said, " . . . the power dropped suddenly to 1,200 rpm and the fuel pressure dropped to approximately 5 pounds." His altitude at that moment was 3,000 feet.

"I attempted to regain power by switching tanks, then by priming, but neither of these attempts had any effect; also, the fuel pump was turned on and carburetor heat applied. I selected a forced landing field and made a left hand pattern to it. Turning on the final approach, with 30 degrees flaps, at approximately 400 to 500 feet altitude I saw high tension lines crossing my approach path. I quickly pulled up and applied 60 degrees flaps, in hopes of clearing the wires and a line of scrubby trees that bordered the field, but the aircraft hit the tree tops, then hit the ground. It spun around 180 degrees and slid backwards to a stop."

Investigation revealed the right tank was dry.

Primary Unsafe Act: "Pilot permitted the right fuel tank to run dry."

Contributing Factors: "(1) Improper fuel management, (2) Premature use of flaps."

The Army Aviation Safety Board concurred in the findings of the Investigation Board; however, the Safety Board added in their analysis of the accident that, "the pilot did not employ the proper emergency procedure to restart the engine."

L-19 Fuel Selector Valve

In the above accident the power failure was due to fuel starvation because the pilot did not switch tanks at the proper interval. However, in the L-19 it is possible to switch tanks, but still be draining fuel out of the unselected tank.

The L-19 fuel tank selector valve consists of two ball-bearing type valves, held in their respective seats by springs. A cam, attached to the fuel selector handle, presses the ball out of its seat when the tank selector handle is turned to a particular tank, thus allowing the fuel to flow around the ball and into the fuel system. If a piece of foreign matter (i.e., metal shavings, sand, dirt, etc.) should flow through the line while the valve is open and lodge between the ball and its seat, the foreign matter will hold the valve open when the selector handle is turned to the other tank. Consequently, fuel will still be draining from the unselected tank and it will eventually run dry. This may confuse the pilot and prompt him to turn the selector handle to the low tank if he thinks something is wrong with the valve or that the handle has been installed incorrectly.

When assembling the valve, it is possible to install the handle incorrectly unless the handle is replaced with the pointer on the "off" position.

Pilots should familiarize themselves with the fuel selector valve on page 139, T.O. 1L-19A-2, dated February 1955.

(HELICOPTER POWERPLANT SYSTEMS *continued from page 22*)

It is apparent, therefore, that for the small central rotor to obtain the same useful power as rotor tip mounted engines, the velocity of the auxiliary rotor must be equal that of the main rotor. Therefore, the angular rotational speed (ω) must be higher, and the acceleration, or "g" loads, on the engines will be that much higher. In the rocket engine this is not very detrimental; however, excessive "g" loads on the operation of both the ram and pulse jet leads to poor combustion properties. One interesting possibility is the application of an outward flow turbine in place of the rotating engine system. This might be mounted above the main rotor system, and gear driven from it. Gas flow from a reaction chamber could then be fed up through the hub into the turbine and then exhausted. If a ram jet type of engine is utilized, it would be necessary to provide a source of pressurized air. This might be produced by an air compressor geared to the turbine shaft. It is interesting to note that this result, in effect, is a gas-turbine. For small helicopters, however, the compactness of this arrangement may prove to be a definite advantage. Also, the application of a compressor for air requirements of the ram jet can provide a considerable improvement in performance because of the higher air pressure possible.

Summary

From this brief review of the possible systems for powering a helicopter, it is hoped that the reader will have had his imagination stimulated so that for future application, he will not be restricted to the conventional solution. As noted previously, the systems discussed herein may never prove to be of any practical significance and the author may, in all probability, have overlooked many of importance. The purpose of this article will have been achieved, however, if it has provided the reader with a new method of approach toward the solution of this type of problem and a new appreciation of the wide latitude of possible helicopter systems available in order to meet the operating requirements which may be forthcoming.

Straight and Level

TO: Editor-in-Chief

How about some articles now and then for prospective Helicopter Pilots (trainees) under the provisions of AR 611-85, and if any have been published, in what issue may they be found?

SFC THOMAS J. BYRD
G1 Sec, Hqs, 6th Army

To date no articles pertaining specifically to prospective helicopter pilots have been published; however, a number of articles concerning helicopter operations have been printed and we anticipate using several more, including helicopter training articles in the next six months.—The Editor

TO: Editor-in-Chief

Enjoyed reading Colonel Matheny's article, "Aerial Vehicle Transport For Combat Units," in the June issue. I think it an outstanding article not only from the organizational concepts which he presents, but also from the point that he has concerned himself solely with Army operations.

He is one of the few officers who has not dragged in inter-service rivalry in his writings. All the services would make much greater progress if they concentrated more on ways and means of improving their particular service and less on other services' operations.

I am sure that Colonel Matheny realizes that present maintenance costs are prohibitive for the type organization which he advocates, but he is looking ahead, and that is what we must do in order to progress.

Many of our service personnel restrict themselves to thinking in terms of our current equipment when evolving organizational concepts. To have progress we must have constant change and to have this change we must think of our future requirements not only for equipment, but organization-wise as Colonel Matheny has.

CHARLES ALLEN
Major, Infantry
USAR

TO: Editor-in-Chief

Your magazine is too dry.

While I occasionally run across articles which have a damp air of life about them, the majority of the material in the Digest is smothered in the dust of technicality.

I usually read each issue, or should I say struggle through each issue, from cover to cover. Why? Because I learn something, but I feel that you people could produce a much more readable magazine.

The articles which you have been publishing are good but why have them so straight-laced? Personally, I would appreciate a little more informal approach and a little humor along with the dosage of technical medicine. In other words, I think the magazine too high-brow. I don't advocate comic book material, but on the other hand, I don't think that a popular-type magazine should read like Einstein's Theory of Relativity. This is a drastic statement, but think you will get my meaning.

GLENN WILLETT
Captain, Infantry
USAR

Letters of constructive criticism are welcomed by the ARMY AVIATION DIGEST. To appear in this column they must be signed.—The Editor